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IN MEMORIAM

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In Memoriam: Cytogeneticist Dr. Sc. Ninel A. Petrova (1940–2024) — life and scientific heritage

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Abstract

The article is dedicated to the memory of Dr. Sc. Ninel A. Petrova, who passed away on 18 April 2024, and to her scientific heritage. Ninel was born on 28 March 1940 in Leningrad, the former Soviet Union. From 1959 to 1964, she studied at the Faculty of Biology and Soil Science of the Leningrad State University. After graduating from the university, Ninel joined the Zoological Institute of the Russian Academy of Sciences, where she worked for almost 60 years, rising from a research assistant to a leading researcher. Her scientific research focused on the structure and evolution of polytene chromosomes of two families of Diptera, black flies (Simuliidae) and non-biting midges (Chironomidae). Ninel has published nearly 200 scientific articles, three monographs and one monograph chapter and has become one of the leading experts in her field. Along with scientific activities, Ninel worked for 25 years as the Scientific Secretary of the Specialized Scientific Council for the Defense of Dissertations at the Zoological Institute.

Keywords

Bibliography, biography, Chironomidae, chromosomal rearrangements, Diptera, evolution, polytene chromosomes, research highlights, Simuliidae, systematics

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Introduction

Dr. Sc. Ninel A. Petrova (Figs 1, 2A–E, 3, 4) passed away on 18 April 2024 after nearly 60 years of work devoted to the cytogenetic and cytotaxonomic studies of insects of the dipteran families Chironomidae (non-biting midges) and Simuliidae (black flies). Her contributions to the understanding of the structure and evolution of polytene chromosomes of Diptera cannot be overestimated. There can be very few scientists working on the comparative cytogenetics and karyosystematics of these groups who have not cited the publications of Ninel Petrova.

Figure 1. Dr. Ninel A. Petrova (photo by P. Michailova).

Life and times

Ninel Petrova was born in the town of Petrodvorets near Leningrad (now Peterhof in St. Petersburg) on 28 March 1940. She never saw her father, who died in the 1939–1940 Soviet-Finnish War. Ninel was just over a year old when the Great Patriotic War (1941–1945) began, and she and her mother were evacuated from besieged Leningrad to the Ryazan Province, to the town of Pronsk. Life in evacuation, hungry and unsettled, was a traumatic experience. Ninel's memories of this period, based largely on her mother's accounts, can be found in the book "War's Tragic Memory: The Great Patriotic War in the Memoirs of the Staff of the Zoological Institute of the Russian Academy of Sciences" (2021).

After the war, the family returned to Leningrad. Ninel's mother remarried, and Ninel had a stepfather. According to her stories, he was a very kind man and did everything possible for her upbringing. In 1957, Ninel graduated from school. She was interested in biology and, after working for two years in different places, she entered the Leningrad State University (now St. Petersburg State University), the Faculty of Biology and Soil Science where she specialized in plant genetics, specifically rye, at the Department of Genetics and Breeding. Her scientific supervisor was Prof. Vasily S. Fedorov (1903–1976), a famous geneticist and breeder, a remarkable scientist, the creator of the genetic collection of rye and the first domestic variety of tetraploid rye "Leningradskaya Tetra". During the dark period of 'Lysenkoism' in the former Soviet Union, Prof. Fedorov introduced students to the basics of genetics in lectures formally devoted to the criticism of classical genetics. He was a wonderful supervisor who played an important role in the shaping of Ninel Petrova as a scientist and whom she remembered with warmth and gratitude all her life. After graduating and defending her diploma project, Ninel joined the Zoological Institute of the Russian Academy of Sciences in Leningrad as a research assistant in the newly established Laboratory of Karyosystematics and Population Genetics and remained there for the whole of her working career. Ninel was very lucky with her teachers. The head of this laboratory was Prof. Lidia A. Chubareva, one of the founders of the cytotaxonomic approach to insect research in the former Soviet Union. During her years of work at the Institute, Ninel rose from a laboratory assistant to a leading researcher. She not only participated in the scientific life of the laboratory, but also for 25 years held the position of the Scientific Secretary of the Specialized Scientific Council for the Defense of Candidate (Ph. D.) and Doctoral (Dr. Sc.) dissertations at the Zoological Institute in the specialties of "Entomology" and "Parasitology". In this position, she contributed to the formation of the scientific team and the maintenance of the scientific community of the institute. Many colleagues who defended their dissertations in those years were very grateful for the help and advice she gave them, especially regarding dissertation documentation and preparation for defense.

Research highlights

Dr. Sc. Ninel Petrova was a scientist who made great and very valuable contributions to the cytotaxonomy and cytogenetics of the large insect order Diptera. Her research focused on two large and practically important families, Simuliidae (black flies) and Chironomidae (non-biting midges), and on their giant polytene chromosomes. These chromosomes are found in the interphase nuclei of the salivary glands of larvae and consist of thousands of DNA strands resulting from multiple replication cycles without separation of sister chromatids. As Ninel has shown in numerous publications, rearrangements detected in polytene chromosomes can be successfully used to solve the problems of systematics and phylogenetics of these insects at various taxonomic levels, from the separation of closely related species to the analysis of phylogenetic relationships between higher taxa.

Under the supervision of Prof. Lidia Chubareva, who was one of the world leaders in cytotaxonomic studies of black flies, Ninel worked on comparative cytogenetics of this highly important group of insects. These studies resulted in a series of publications, first jointly with her supervisor (e.g., Chubareva and Petrova 1968, 1969) and then independently (Petrova 1972, and others) or with other colleagues (see List of main publications at the end of the article and Supplementary file 1). Many of her taxonomic publications have successfully combined karyological and morphological approaches. On the example of several taxa of black flies (the genera *Cnephia* Enderlein, 1921, *Helodon* Enderlein, 1921, *Schoenbaueria* Enderlein, 1921, *Austrosimulium* Tonnoir, 1925, and others), Ninel Petrova demonstrated how karyological characteristics can be used to clarify the status and position of taxa as well as the phylogenetic relationships between them. In one of her earlier publications (Petrova et al. 1971), devoted to a large and widespread genus *Simulium* Latreille, 1802 and published in co-authorship with Prof. Ivan A. Rubtsov, a well-known Russian expert in the systematics of Simuliidae, the prospect of using chromosomal characters to distinguish closely related species differing only slightly in external morphology was clearly demonstrated. In 1975, Ninel successfully defended her Candidate (Ph. D.) dissertation "Comparative karyological study of bloodsucking black flies of the genera *Cnephia* End., *Metacnephia* Crossk. and *Sulcicnephia* Rubz. (Diptera, Simuliidae)".

After nearly a decade devoted to the study of Simuliidae, in the late 1970s Ninel began to apply karyotaxonomic methods and approaches to another large and diverse dipteran family, Chironomidae, without leaving her first object, Simuliidae. In 1992, she successfully defended her Doctoral dissertation entitled "Polytene chromosomes of chironomids and simuliids, their use in the study of the systematics and evolution of these insect groups (Diptera: Chironomidae, Simuliidae)" and was awarded a well-deserved scientific degree "Doctor of Sciences" (D. Sc.). Ninel has made a great contribution to the knowledge of structural and functional organization of dipteran polytene chromosomes and to the cytotaxonomy of Simuliidae and Chironomidae. Ongoing research on the former led to the publication (in co-authorship with Prof. Chubareva) of the world's first review of karyotypes of black flies (Chubareva and Petrova 2008).

This book (with the subtitle 'Atlas') contains the detailed cytophotomaps of polytene chromosomes of 124 species in 32 genera of black flies of Russia and neighboring countries (descriptions and drawings of taxonomically significant morphological characters of the studied species were also provided). This monograph has become a desktop book for all specialists dealing with comparative cytogenetics of black flies.

Since then, Ninel has focused her efforts mostly on the study of polytene chromosomes and karyosystematics of the family Chironomidae (although she has also published important papers on black flies during these years), which is of both theoretical and practical interest. Chironomid larvae are widely distributed and abundant in aquatic ecosystems, where they play an important role. Ninel carefully studied the morphological characteristics of polytene chromosomes of species from different phylogenetic lineages and subfamilies within the family Chironomidae. Her original chromosome maps of chironomid species from five subfamilies are not only of great taxonomic importance, but have also been successfully used to trace species relatedness at the cytogenetic level (Petrova et al. 2000).

Ninel studied the structural and functional organization of polytene chromosomes of chironomids originating from different regions of Russia and from other countries, including Mongolia, Lithuania, Italy, Bulgaria, Belarus, Ukraine and others (Petrova 1990; Petrova et al. 1986, 1992, 2000, 2004, 2013, 2014a, b). During her life, she participated in many scientific expeditions to collect the material, e.g. to the European North, the Caucasus, Tajikistan and Kyrgyzstan (Fig. 2A, B, D).

Ninel's studies on the variability of polytene chromosomes are also very important because they take into account both seasonal and geographical variability in their band structure (Petrova 1990; Petrova et al. 2004, 2014a, b). She has made a remarkable contribution to the use of polytene chromosomes of model chironomid species to trace metal pollution in various aquatic ecosystems. Because of her authority as a brilliant expert on chironomid cytogenetics, she was invited to participate in two NATO projects named, respectively, "Polytene chromosomes as a model for heavy metal-induced genome instability" (2004–2006) and "Pollution of water resources assessed by genome alterations in midges (2008–2010)". As part of these projects carried out jointly with Bulgarian and Italian colleagues (Fig. 3), Ninel studied the influence of heavy metals on the structural and functional organization of chromosomes of model species of chironomids collected in Russia, Bulgaria and Italy. She has been actively involved in the development of these projects and has established the presence of both multiple heritable and a number of somatic chromosomal rearrangements (Michailova et al. 1996, 1998, 2012; Petrova and Michailova 2002; Petrova 2013; Michailova and Petrova 2015). During these years, Ninel conducted classes and lectures for students from Turin and Milan. Using her knowledge and skills, the research team conducted a number of laboratory experiments with heavy metal ions, which have led to practically important conclusions about the genotoxic effect of some of them (Michailova et al. 2001a, b). This study confirmed that the chironomid genome is a very sensitive structure and responds much more strongly to toxicants than the external morphology of larvae.

Figure 2. Photos of Ninel A. Petrova **A** with L.A. Chubareva (at left), expedition to Azerbaijan, 1969 **B** with E.A. Kachvoryan (at right), 1990s (?) **C** with N.V. Golub (at left), N.V. Khabazova and V.G. Kuznetsova (at right), at Zoological Institute (St. Petersburg), September 1997 **D** expedition to Tajikistan (?), 1975 **E** at Zoological Institute (St. Petersburg), 27 January 2014. (**A–D** photos from personal archive of N.A. Petrova; **E** photo by A.A. Przhiboro).

Figure 3. Photo of Ninel A. Petrova with Bulgarian and Italian colleagues, participants of the NATO project (Turin, 2010). P. Michailova (at left), L. Ramella, S. Bovero and G. Sella (at right).

The extraordinary self-sacrifice of N. Petrova in the name of science deserves special mention. She conducted herself in the field like a true scientist, collecting the scientific material. Without a moment's hesitation, she went to Chernobyl (Ukraine) after the accident at the nuclear power station (26 April 1986) and collected chironomids to study the influence of radiation on the structural and functional organization of their polytene chromosomes. This activity resulted in her research on the chromosomal variability of chironomid species from Chernobyl (Michailova and Petrova 1994; Petrova and Michailova 1996a, b).

During her long life in science, Ninel published about 200 scientific articles, three monographs (Chubareva and Petrova 2008; Petrova 2013; Petrova and Zhirov 2022) and a chapter (Belyanina et al. 1983) in an important collective monograph. Using combined analysis of chromosomes and morphological characters, she discovered and described five new species and two genera of Simuliidae (Petrova 1977, 1983; Chubareva and Petrova 1981; Petrova et al. 1995; see the list of taxa below). Also, as part of an international research team, she described a new chironomid species *Polypedilum pembai* Cornette et al. from Malawi, southeastern Africa (Cornette et al. 2017). This species is notable for the ability of its larvae to survive the dry season in a completely dehydrated ametabolic state known as anhydrobiosis, similar to that in its widely known congener, *P. vanderplankii* Hinton, 1951. Although *P. pembai* has been described based on a suite of features including adult, larval and pupal morphology and

DNA sequencing results, its independence was initially inferred based on the chromosomal data obtained by Ninel (Petrova et al. 2015). One species of Simuliidae and one genus of Chironomidae were named in honor of Ninel Petrova (see below).

An important result of Dr. Petrova's research on chironomids was her last monograph "Structure of polytene chromosomes and morphology of chironomid larvae (Diptera, Chironomidae)" (Petrova and Zhirov 2022). In this book, Ninel together with her former Ph. D. student, the late Sergey V. Zhirov (Kuznetsova et al. 2019), reviewed the data on the polytene chromosomes in larvae belonging to five subfamilies of Chironomidae. This book is mostly based on the authors' original materials and contains original microphotographs of polytene chromosomes. In addition to the chromosomal data, it includes the data on larval morphology. This monograph summarized valuable comparative information on polytene chromosome morphology and chromosomal polymorphism in different populations and species of Chironomidae.

Ninel was a researcher who collaborated productively with colleagues in Russia and some other countries such as Bulgaria, Italy and Armenia. She enjoyed passing on her knowledge and skills to younger colleagues who came to her laboratory and teaching them working with polytene chromosomes. The Zoological Institute and the Department of Karyosystematics, where she worked, have lost a remarkable scientist devoted to science in general.

Scientific presentations

Ninel Petrova has repeatedly made excellent presentations at national (Soviet and All-Russian) and international conferences and congresses. We will list just a few of them, such as all five International Conferences on Karyosystematics of Invertebrate Animals (in 1979 and 2006 in Leningrad/St. Petersburg, in 1991 in Cheboksary, in 1997 in Moscow, in 2010 in Novosibirsk and in 2016 in Saratov), International Symposia on Chironomidae (e.g., in 1997 in Freiburg, Germany), Congresses of the All-Russian Entomological Society (e.g., in 2002 and 2012 (Fig. 4) in St. Petersburg, in 2007 in Krasnodar, and in 2017 in Novosibirsk), Congresses of the Russian Society of Geneticists and Breeders (e.g., in 2014 in Rostov-on-Don and in 2019 in St. Petersburg), All-Russian Dipterological Symposia (e.g., in 2016 in Krasnodar and in 2020 in Voronezh), the X International Balbiani Ring Workshop (in 2021 in Varna, Bulgaria) and many others. Her reports have always been received with great interest.

The taxa described by Ninel Petrova

In Chironomidae

Polypedilum pembai Cornette, N. Yamamoto, M. Yamamoto, Kobayashi, Petrova, Gusev, Shimura, Kikawada, Pemba et Okuda, 2017

In Simuliidae

Levitinia Chubareva et Petrova, 1981
Levitinia tacobi Chubareva et Petrova, 1981
Metacnephia pamiriensis Petrova, 1977
Metacnephia paraskevae Petrova, Chubareva et Kachvoryan, 1995
Prosimulium pamiricum Chubareva et Petrova, 1983
Rubzovia Petrova, 1983 [described as a genus; currently recognized as a subgenus of *Simulium*]
Rubzovia vantshi Petrova, 1983 [current name: *Simulium* (*Rubzovia*) *vantshi* (Petrova, 1983)]

The taxa named in honor of Ninel Petrova

In Chironomidae

Ninelia E. Makarchenko et M. Makarchenko, 2004 [described with the wording: 'described in honor of … N.A. Petrova, a kind and sympathetic person who devoted most of her life to chironomid karyology, moral (and not only moral) support of young (and not so young) Russian chironomidologists'].

Figure 4. Photo of Ninel A. Petrova with colleagues, participants of the XIV All-Russian Entomological Congress, Section of karyosystematics (2012, St. Petersburg). N.A. Petrova, N.V. Golub, V.G. Kuznetsova, S.V. Zhirov, N.V. Durnova, V.E. Gokhman, S.M. Grozeva, and V.A. Lukhtanov (right to left).

In Simuliidae

Sulcicnephia petrovae Rubtsov, 1976 [described with the wording: 'named after Ninel Alekseevna Petrova, who collected the material in difficult conditions of the high-mountain country'].

Note: All listed taxonomic names are currently valid.

Awards

Ninel Petrova was repeatedly awarded prizes and diplomas for her scientific achievements. One of the most significant awards for her was the medal "For the Rescue of the Perished", which she received in the framework of the Decree of the President of the Russian Federation № 419 of 21.04.2006 "On awarding state awards of the Russian Federation to active participants of liquidation of consequences of the accident at the Chernobyl Nuclear Power Plant".

Personal characteristics

Ninel was a sweet, friendly and very creative person. Her interactions with colleagues and friends were always very kind and even-keeled. She was passionate about music, classical Russian literature and painting, and enjoyed attending concerts and exhibitions in her beautiful city of St. Petersburg. Ninel passed on her hobbies to her daughter Olga, who teaches literature and Russian language at a school in St. Petersburg.

Conclusions

Ninel passed away at the age of 84 years old. Throughout her life she carried a sincere interest in science, working in the same laboratory for almost 60 years and becoming one of the leading specialists in her field. Ninel's colleagues and friends will always remember her as a wonderful professional and a very kind person. We express our deepest grief on the death of our dear friend and colleague. She will always live in our hearts and memories.

List of main publications by Ninel Petrova

The publications mentioned in the above text are asterisked. A more complete list of publications by N.A. Petrova with comments (compiled by A. Przhiboro) is given as Suppl. material 1.

1968

*Chubareva LA, Petrova NA (1968) Homologous lines of chromosome polymorphism in the natural populations of blackflies (Diptera, Simuliidae). Tsitologiya 10(10): 1248–1256. [In Russian with English summary].

1969

*Chubareva LA, Petrova NA (1969) Karyological peculiarities of *Helodon ferrugineus* Wahlb. in relation to some questions of systematics. Tsitologiya 11(2): 234–241. [In Russian with English summary].

1971

Chubareva LA, Petrova NA, Petrukhina TE (1971) The structural peculiarities of the polytene chromosomes and the taxonomy of the black flies (Diptera, Simuliidae). Tsitologiya 13(6): 784–789. [In Russian with English summary].

*Petrova NA, Rubtsov IA, Chubareva LA (1971) On the position of *Simulium* (*Schönbaueria*) *gigantea* Rubz. in the system of classification of simuliids (Morphological and karyological characters in the systematics). Parazitologiya 5(1): 40–50. [In Russian with English translation in Parasitology, 1972, 1(1): 45–57].

1972

*Petrova NA (1972) Karyological features of the Karelian black flies [sic!] of the genus *Cnephia* End. Tsitologiya 14(6): 769–773, 2 plates. [In Russian with English summary].

1973

Petrova NA (1973) A comparative karyological analysis of three genera of the family Simuliidae (Diptera). Tsitologiya 15(8): 1055–1059. [In Russian with English summary].

Petrova NA (1973) A comparative karyological study of 3 species of black-flies of the genus *Metacnephia* Crosskey (Diptera, Simuliidae) from Armenia. Tsitologiya 15(4): 439–445, 3 plates. [In Russian with English summary].

1974

Petrova NA (1974) Inversional polymorphism in natural populations of two species of black flies (Diptera, Simuliidae). Genetika 10(1): 80–89. [In Russian with English summary].

1975

Chubareva LA, Petrova NA (1975) Karyotype of the plesiomorphic New Zealand species *Austrosimulium tillyardi* and its genetical relations with some other genera of the family Simuliidae (Diptera). Zoologicheskii Zhurnal 54(4): 552–558. [In Russian with English summary].

*Petrova NA (1975) Comparative karyological study of blood-sucking black flies of the genera *Cnephia* End., *Metacnephia* Crossk. and *Sulcicnephia* Rubz. (Diptera, Simuliidae). Candidate of Biological Sciences Dissertation, Leningrad: Zoological Institute, Academy of Sciences of the USSR, 242 pp. [In Russian].

1976

Chubareva LA, Rubtsov IA, Petrova NA (1976) Morphological and karyological similarities and differences in Palearctic and Neotropical species of the genus *Hemicnetha* End. (Diptera, Simuliidae). Entomologicheskoe Obozrenie 55(2): 452–457. [In Russian with English translation in Entomological Review, 1976, 55(2): 137–142].

1977

*Petrova NA (1977) A new species of black flies; *Metacnephia pamiriensis* sp. n. (Simuliidae) from Pamir. Parazitologiya 11(3): 210–212, 1 plate. [In Russian with English summary].

Petrova NA, Chubareva LA, Kuzmenko KN (1977) The karyotypes of five species of Chironomidae (Diptera). Tsitologiya 19(8): 900–905. [In Russian with English summary].

Rubtsov IA, Petrova NA (1977) Blackflies of the tribe Cnephiini (Diptera, Simuliidae) and diagnoses of the genera *Cnephia* Enderlein and *Astega* Enderlein. Entomologicheskoe Obozrenie 56(3): 691–697. [In Russian with English translation in Entomological Review, 1977, 56(3): 145–149].

1978

Maksimova FL, Petrova NA (1978) Geographical variability of karyotype in *Chironomus plumosus* (Diptera, Chironomidae). Zoologicheskii Zhurnal 57(12): 1816–1826. [In Russian with English summary].

Petrova NA, Chubareva LA (1978) The peculiarities of the karyotype of *Prodiamesa olivacea* Meig. (Diptera, Chironomidae, Orthocladiinae). Tsitologiya 20(10): 1208–1211. [In Russian with English summary].

Petrova NA, Maksimova FL (1978) The role of chromosome rearrangements in the speciation of chironomids (Diptera, Chironomidae). Genetika 14(7): 1201–1207. [In Russian with English translation in Soviet Genetics, 1978, 14: 849–853].

1979

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1980

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Maksimova FL, Petrova NA (1980) On the problem of sympatric species evolution in chironomids (Diptera, Chironomidae). In: Lukina EV (Ed.) Problems of Population Cytogenetics of Plants and Animals, pp. 70–76. [In Russian].

Pankratova VYa, Chubareva LA, Petrova NA (1980) On the systematics of some *Chironomus* species (Chironomidae) from the Lake Sevan. In: Chubareva LA (Ed.) New Data on Karyosystematics of Dipterous Insects. Trudy Zoologicheskogo Instituta AN SSSR, 95: 50–54. [In Russian with English summary].

Petrova NA (1980) Cytological sex determination of blackflies (Simuliidae). In: Chubareva LA (Ed.) New Data on Karyosystematics of Dipterous Insects. Trudy Zoologicheskogo Instituta AN SSSR, 95: 55–58. [In Russian with English summary].

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1981

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1982

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1983

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1984

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Supplementary material 1

A list of publications by Ninel Petrova (compiled by A. Przhiboro)
Authors: Valentina Kuznetsova, Paraskeva Michailova, Andrey Przhiboro, Natalia Khabazova
Data type: docx
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Link: https://doi.org/10.3897/compcytogen.18.138747.suppl1